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33

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GEOCENTRIC SOLAR DATA

by

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GEOCENTRIC SOLAR DATA

This *Circular* contains geocentric solar data for each day in 1978 at 0^h Universal (Greenwich) Time, referred to the equator and equinox of date. These data may be used to determine the position of the Sun in the sky at a given date and time in any year, with low accuracy.

The seven columns tabulated are: (1) the date; (2) the declination of the Sun in degrees, minutes, and seconds of arc; (3) the daily difference of the declination in minutes and seconds of arc; (4) the equation of time in minutes and seconds of time; (5) the daily difference of the equation of time in seconds of time; (6) the semidiameter of the solar disk in minutes and seconds of arc; (7) the distance between the centers of the Sun and Earth in astronomical units.

These data were derived from calculated positions of the Sun for each date in 1978 at 0^h Ephemeris Time, with the declination, equation of time, semidiameter, and distance values adjusted for the projected value of ΔT for 1978, 49.8 seconds. Since all values were rounded before printing, occasional end-figure discrepancies may exist in the difference columns.

Use of the tables for years other than 1978 in the second half of the twentieth century should result in errors no larger than 15′ in declination, 20^s in equation of time, 0″.6 in semidiameter, and 0.0003 A.U. in distance. Considerably more accurate values of declination and equation of time for years other than 1978 can be obtained by using the following formula:

$$V' = V + (\Delta V \times C') \qquad (1)$$

where:

V' = value of quantity needed (declination or equation of time) for a given date
V = the 1978 tabulated value
ΔV = the 1978 tabulated daily difference
C' = a correction factor (see page 4).

Use of the above formula should result in errors no larger than 3′ in declination and 5^s in equation of time, and generally less.

The equation of time, Q, represents the difference between local apparent solar time and local mean solar time: Q=Apparent−Mean. If the value of Q is known for some local mean solar time, M, the local hour angle, h, of the Sun at that time is h = M−12 hours + Q, where h is positive if the Sun is west of the meridian, and negative if it is east of the meridian.

If an observer's latitude is known, the altitude, a, and the azimuth angle, x, of the Sun at a given local time can be calculated from:

$$\sin a = \sin \phi \sin \delta + \cos \phi \cos \delta \cos h \qquad (2)$$

$$\tan x = \frac{-\sin h}{\cos \phi \tan \delta - \sin \phi \cos h} \qquad (3)$$

where:

h = local hour angle of the Sun
δ = declination of the Sun
ϕ = observer's latitude (positive for Northern hemisphere, negative for Southern),

and where x determines the true azimuth, A, of the Sun, depending on whether the denominator of (3) is positive or negative:

$$A = 360° + x \text{ if the denominator is positive and h is positive}$$
$$= x \quad \text{if the denominator is positive and h is negative}$$
$$= 180° + x \text{ if the denominator is negative.}$$

The zenith distance, z, of the Sun is $90° - a$.

The altitude of the Sun thus obtained does not take into account refraction by the Earth's atmosphere nor the parallax of the Sun due to the Earth's radius. Both of these corrections are maximum when the Sun is on the horizon. For most purposes the parallax correction is negligible (approximately 8".8 for the Sun on the horizon) but the refraction correction, R, in seconds of arc, is:

$$R = 58.29 \tan z - 0.07 \tan^3 z. \qquad (4)$$

The observed altitude of the Sun is then the calculated altitude, a, from formula (2), plus R. Formula (4) assumes average atmospheric conditions (barometric pressure of 30 inches and temperature of 50°F); it yields unreliable results under extreme conditions or when the zenith distance, z, exceeds 75°.

Correction Factors for Various Years

Year	Correction Factor C'
1970	−0.062
1971	−0.305
1972*	−0.547, +0.453
1973	+0.211
1974	−0.031
1975	−0.273
1976*	−0.516, +0.484
1977	+0.242
1978	0.000
1979	−0.242
1980*	−0.484, +0.516
1981	+0.273
1982	+0.031
1983	−0.211
1984*	−0.453, +0.547
1985	+0.305

*Use the first value given for dates in January and February, and the second value for dates in the remainder of the year.

DATE	DEC	DIFF	EQ OF T	DIFF	SD	DIST
	° ' ''	' ''	M S	S	' ''	AU
DEC 30	- 23 11 14.5	+ 3 59.6	- 2 18.6	- 28.9	16 17.5	0.9833347
31	- 23 7 14.9	+ 4 27.5	- 2 47.5	- 28.6	16 17.5	0.9833209
JAN 1	- 23 2 47.3	+ 4 55.1	- 3 16.1	- 28.3	16 17.5	0.9833128
2	- 22 57 52.2	+ 5 22.6	- 3 44.4	- 28.0	16 17.5	0.9833102
3	- 22 52 29.6	+ 5 49.9	- 4 12.4	- 27.7	16 17.5	0.9833130
4	- 22 46 39.7	+ 6 17.1	- 4 40.1	- 27.3	16 17.5	0.9833207
5	- 22 40 22.6	+ 6 44.1	- 5 7.4	- 26.9	16 17.5	0.9833331
6	- 22 33 38.5	+ 7 10.8	- 5 34.3	- 26.5	16 17.4	0.9833497
7	- 22 26 27.6	+ 7 37.5	- 6 0.7	- 26.0	16 17.4	0.9833703
8	- 22 18 50.1	+ 8 3.6	- 6 26.7	- 25.5	16 17.4	0.9833947
9	- 22 10 46.5	+ 8 29.8	- 6 52.2	- 25.0	16 17.4	0.9834227
10	- 22 2 16.7	+ 8 55.6	- 7 17.2	- 24.4	16 17.3	0.9834542
11	- 21 53 21.1	+ 9 21.1	- 7 41.6	- 23.8	16 17.3	0.9834891
12	- 21 43 60.0	+ 9 46.3	- 8 5.4	- 23.2	16 17.3	0.9835278
13	- 21 34 13.7	+ 10 11.4	- 8 28.7	- 22.6	16 17.2	0.9835703
14	- 21 24 2.2	+ 10 36.1	- 8 51.2	- 21.9	16 17.2	0.9836170
15	- 21 13 26.1	+ 11 0.5	- 9 13.2	- 21.2	16 17.1	0.9836681
16	- 21 2 25.6	+ 11 24.6	- 9 34.4	- 20.5	16 17.1	0.9837239
17	- 20 51 1.0	+ 11 48.4	- 9 54.9	- 19.8	16 17.0	0.9837846
18	- 20 39 12.6	+ 12 11.8	- 10 14.7	- 19.1	16 17.0	0.9838505
19	- 20 27 0.8	+ 12 34.9	- 10 33.8	- 18.3	16 16.9	0.9839220
20	- 20 14 25.9	+ 12 57.8	- 10 52.1	- 17.6	16 16.8	0.9839989
21	- 20 1 28.0	+ 13 20.2	- 11 9.7	- 16.8	16 16.7	0.9840815
22	- 19 48 7.8	+ 13 42.2	- 11 26.6	- 16.1	16 16.6	0.9841701
23	- 19 34 25.6	+ 14 4.0	- 11 42.6	- 15.3	16 16.5	0.9842645
24	- 19 20 21.6	+ 14 25.4	- 11 57.9	- 14.5	16 16.4	0.9843648
25	- 19 5 56.2	+ 14 46.4	- 12 12.4	- 13.7	16 16.3	0.9844712
26	- 18 51 9.8	+ 15 7.1	- 12 26.0	- 12.9	16 16.2	0.9845835
27	- 18 36 2.7	+ 15 27.3	- 12 38.9	- 12.1	16 16.1	0.9847018
28	- 18 20 35.4	+ 15 47.3	- 12 51.0	- 11.3	16 16.0	0.9848258
29	- 18 4 48.0	+ 16 6.8	- 13 2.3	- 10.5	16 15.9	0.9849555
30	- 17 48 41.2	+ 16 25.9	- 13 12.8	- 9.7	16 15.7	0.9850905
31	- 17 32 15.3	+ 16 44.7	- 13 22.6	- 8.9	16 15.6	0.9852307
FEB 1	- 17 15 30.6	+ 17 3.0	- 13 31.5	- 8.1	16 15.4	0.9853757
2	- 16 58 27.6	+ 17 21.0	- 13 39.6	- 7.3	16 15.3	0.9855250
3	- 16 41 6.6	+ 17 38.5	- 13 46.9	- 6.5	16 15.1	0.9856785
4	- 16 23 28.1	+ 17 55.6	- 13 53.4	- 5.7	16 15.0	0.9858355
5	- 16 5 32.5	+ 18 12.3	- 13 59.1	- 4.9	16 14.8	0.9859958
6	- 15 47 20.2	+ 18 28.5	- 14 4.1	- 4.1	16 14.7	0.9861592
7	- 15 28 51.7	+ 18 44.3	- 14 8.2	- 3.3	16 14.5	0.9863253
8	- 15 10 7.3	+ 18 59.6	- 14 11.5	- 2.5	16 14.3	0.9864941
9	- 14 51 7.7	+ 19 14.6	- 14 14.1	- 1.7	16 14.2	0.9866653
10	- 14 31 53.1	+ 19 29.2	- 14 15.8	- 1.0	16 14.0	0.9868392
11	- 14 12 23.9	+ 19 43.2	- 14 16.8	- 0.2	16 13.8	0.9870158
12	- 13 52 40.7	+ 19 56.9	- 14 16.9	+ 0.6	16 13.6	0.9871953
13	- 13 32 43.8	+ 20 10.1	- 14 16.3	+ 1.4	16 13.5	0.9873779
14	- 13 12 33.7	+ 20 23.0	- 14 14.9	+ 2.2	16 13.3	0.9875639
15	- 12 52 10.7	+ 20 35.4	- 14 12.8	+ 2.9	16 13.1	0.9877534
16	- 12 31 35.3	+ 20 47.4	- 14 9.9	+ 3.6	16 12.9	0.9879466
17	- 12 10 47.9	+ 20 59.0	- 14 6.2	+ 4.4	16 12.7	0.9881436
18	- 11 49 48.9	+ 21 10.1	- 14 1.9	+ 5.1	16 12.5	0.9883447
19	- 11 28 38.8	+ 21 21.0	- 13 56.8	+ 5.7	16 12.3	0.9885499
20	- 11 7 17.8	+ 21 31.2	- 13 51.1	+ 6.4	16 12.1	0.9887594
21	- 10 45 46.6	+ 21 41.3	- 13 44.6	+ 7.1	16 11.9	0.9889731
22	- 10 24 5.2	+ 21 50.8	- 13 37.6	+ 7.7	16 11.7	0.9891914
23	- 10 2 14.4	+ 22 0.0	- 13 29.8	+ 8.3	16 11.5	0.9894141
24	- 9 40 14.4	+ 22 8.9	- 13 21.5	+ 8.9	16 11.2	0.9896414
25	- 9 18 5.5	+ 22 17.2	- 13 12.5	+ 9.5	16 11.0	0.9898730
26	- 8 55 48.3	+ 22 25.3	- 13 3.0	+ 10.1	16 10.8	0.9901089
27	- 8 33 23.0	+ 22 32.9	- 12 52.9	+ 10.6	16 10.5	0.9903488
28	- 8 10 50.1	+ 22 40.2	- 12 42.3	+ 11.2	16 10.3	0.9905925
MAR 1	- 7 48 9.9	+ 22 47.1	- 12 31.1	+ 11.6	16 10.1	0.9908398

DATE		DEC	DIFF	EQ OF T	DIFF	SD	DIST
		° ' ''	' ''	M S	S	' ''	AU
MAR	2	- 7 25 22.8	+ 22 53.5	- 12 19.5	+ 12.1	16 9.8	0.9910901
	3	- 7 2 29.3	+ 22 59.6	- 12 7.3	+ 12.6	16 9.6	0.9913432
	4	- 6 39 29.7	+ 23 5.3	- 11 54.8	+ 13.0	16 9.3	0.9915985
	5	- 6 16 24.4	+ 23 10.6	- 11 41.7	+ 13.5	16 9.1	0.9918558
	6	- 5 53 13.8	+ 23 15.4	- 11 28.3	+ 13.9	16 8.8	0.9921146
	7	- 5 29 58.4	+ 23 19.8	- 11 14.4	+ 14.3	16 8.6	0.9923747
	8	- 5 6 38.6	+ 23 23.9	- 11 0.1	+ 14.6	16 8.3	0.9926355
	9	- 4 43 14.7	+ 23 27.5	- 10 45.5	+ 15.0	16 8.1	0.9928971
	10	- 4 19 47.2	+ 23 30.8	- 10 30.5	+ 15.4	16 7.8	0.9931592
	11	- 3 56 16.4	+ 23 33.7	- 10 15.1	+ 15.7	16 7.5	0.9934219
	12	- 3 32 42.7	+ 23 36.1	- 9 59.4	+ 16.0	16 7.3	0.9936852
	13	- 3 9 6.6	+ 23 38.2	- 9 43.4	+ 16.3	16 7.0	0.9939492
	14	- 2 45 28.4	+ 23 39.9	- 9 27.1	+ 16.6	16 6.8	0.9942141
	15	- 2 21 48.5	+ 23 41.2	- 9 10.5	+ 16.9	16 6.5	0.9944800
	16	- 1 58 7.3	+ 23 42.2	- 8 53.7	+ 17.1	16 6.3	0.9947471
	17	- 1 34 25.1	+ 23 42.8	- 8 36.5	+ 17.3	16 6.0	0.9950155
	18	- 1 10 42.3	+ 23 42.9	- 8 19.2	+ 17.5	16 5.7	0.9952855
	19	- 0 46 59.4	+ 23 42.8	- 8 1.7	+ 17.7	16 5.5	0.9955569
	20	- 0 23 16.6	+ 23 42.3	- 7 44.0	+ 17.9	16 5.2	0.9958301
	21	+ 0 0 25.7	+ 23 41.4	- 7 26.2	+ 18.0	16 4.9	0.9961052
	22	+ 0 24 7.1	+ 23 40.2	- 7 8.2	+ 18.1	16 4.7	0.9963822
	23	+ 0 47 47.3	+ 23 38.6	- 6 50.1	+ 18.2	16 4.4	0.9966614
	24	+ 1 11 25.9	+ 23 36.8	- 6 31.9	+ 18.3	16 4.1	0.9969428
	25	+ 1 35 2.7	+ 23 34.5	- 6 13.6	+ 18.3	16 3.8	0.9972263
	26	+ 1 58 37.2	+ 23 31.9	- 5 55.3	+ 18.3	16 3.6	0.9975119
	27	+ 2 22 9.1	+ 23 29.1	- 5 37.0	+ 18.3	16 3.3	0.9977997
	28	+ 2 45 38.2	+ 23 25.8	- 5 18.7	+ 18.3	16 3.0	0.9980892
	29	+ 3 9 4.0	+ 23 22.2	- 5 0.5	+ 18.2	16 2.7	0.9983803
	30	+ 3 32 26.2	+ 23 18.4	- 4 42.2	+ 18.1	16 2.5	0.9986726
	31	+ 3 55 44.6	+ 23 14.0	- 4 24.1	+ 18.0	16 2.2	0.9989657
APR	1	+ 4 18 58.6	+ 23 9.5	- 4 6.1	+ 17.9	16 1.9	0.9992593
	2	+ 4 42 8.1	+ 23 4.4	- 3 48.1	+ 17.8	16 1.6	0.9995529
	3	+ 5 5 12.5	+ 22 59.1	- 3 30.4	+ 17.6	16 1.3	0.9998462
	4	+ 5 28 11.6	+ 22 53.5	- 3 12.7	+ 17.5	16 1.0	1.0001386
	5	+ 5 51 5.1	+ 22 47.3	- 2 55.3	+ 17.3	16 0.8	1.0004299
	6	+ 6 13 52.4	+ 22 41.0	- 2 38.0	+ 17.1	16 0.5	1.0007197
	7	+ 6 36 33.4	+ 22 34.1	- 2 20.9	+ 16.9	16 0.2	1.0010079
	8	+ 6 59 7.5	+ 22 27.1	- 2 4.0	+ 16.6	15 59.9	1.0012943
	9	+ 7 21 34.6	+ 22 19.5	- 1 47.4	+ 16.4	15 59.7	1.0015789
	10	+ 7 43 54.1	+ 22 11.8	- 1 31.0	+ 16.2	15 59.4	1.0018616
	11	+ 8 6 5.9	+ 22 3.5	- 1 14.8	+ 15.9	15 59.1	1.0021426
	12	+ 8 28 9.4	+ 21 55.0	- 0 58.9	+ 15.6	15 58.9	1.0024219
	13	+ 8 50 4.4	+ 21 46.2	- 0 43.3	+ 15.3	15 58.6	1.0026995
	14	+ 9 11 50.6	+ 21 36.8	- 0 28.0	+ 15.0	15 58.3	1.0029757
	15	+ 9 33 27.3	+ 21 27.4	- 0 13.0	+ 14.7	15 58.1	1.0032507
	16	+ 9 54 54.7	+ 21 17.3	+ 0 1.6	+ 14.3	15 57.8	1.0035243
	17	+ 10 16 12.0	+ 21 7.2	+ 0 16.0	+ 14.0	15 57.5	1.0037970
	18	+ 10 37 19.2	+ 20 56.6	+ 0 30.0	+ 13.6	15 57.3	1.0040688
	19	+ 10 58 15.8	+ 20 45.6	+ 0 43.5	+ 13.2	15 57.0	1.0043399
	20	+ 11 19 1.4	+ 20 34.5	+ 0 56.8	+ 12.8	15 56.8	1.0046104
	21	+ 11 39 35.9	+ 20 22.8	+ 1 9.6	+ 12.4	15 56.5	1.0048806
	22	+ 11 59 58.7	+ 20 11.0	+ 1 21.9	+ 12.0	15 56.3	1.0051505
	23	+ 12 20 9.7	+ 19 58.9	+ 1 33.9	+ 11.5	15 56.0	1.0054202
	24	+ 12 40 8.6	+ 19 46.4	+ 1 45.4	+ 11.0	15 55.7	1.0056898
	25	+ 12 59 55.0	+ 19 33.6	+ 1 56.4	+ 10.5	15 55.5	1.0059591
	26	+ 13 19 28.6	+ 19 20.5	+ 2 7.0	+ 10.0	15 55.2	1.0062280
	27	+ 13 38 49.1	+ 19 7.1	+ 2 17.0	+ 9.5	15 55.0	1.0064961
	28	+ 13 57 56.2	+ 18 53.4	+ 2 26.5	+ 9.0	15 54.7	1.0067632
	29	+ 14 16 49.5	+ 18 39.4	+ 2 35.5	+ 8.5	15 54.5	1.0070289
	30	+ 14 35 28.9	+ 18 25.0	+ 2 44.0	+ 7.9	15 54.2	1.0072928
MAY	1	+ 14 53 53.9	+ 18 10.2	+ 2 51.9	+ 7.4	15 54.0	1.0075545
	2	+ 15 12 4.1	+ 17 55.3	+ 2 59.2	+ 6.8	15 53.7	1.0078134

DATE		DEC	DIFF	EQ OF T	DIFF	SD	DIST
		° ' ''	' ''	M S	S	' ''	AU
MAY	3	+ 15 29 59.4	+ 17 39.9	+ 3 6.0	+ 6.2	15 53.5	1.0080694
	4	+ 15 47 39.3	+ 17 24.3	+ 3 12.3	+ 5.7	15 53.2	1.0083222
	5	+ 16 5 3.6	+ 17 8.3	+ 3 18.0	+ 5.1	15 53.0	1.0085713
	6	+ 16 22 11.9	+ 16 52.0	+ 3 23.1	+ 4.5	15 52.8	1.0088168
	7	+ 16 39 3.9	+ 16 35.4	+ 3 27.6	+ 4.0	15 52.5	1.0090583
	8	+ 16 55 39.3	+ 16 18.4	+ 3 31.6	+ 3.4	15 52.3	1.0092957
	9	+ 17 11 57.7	+ 16 1.3	+ 3 35.0	+ 2.8	15 52.1	1.0095291
	10	+ 17 27 58.9	+ 15 43.7	+ 3 37.8	+ 2.3	15 51.9	1.0097585
	11	+ 17 43 42.6	+ 15 25.8	+ 3 40.1	+ 1.7	15 51.7	1.0099840
	12	+ 17 59 8.4	+ 15 7.8	+ 3 41.9	+ 1.2	15 51.5	1.0102057
	13	+ 18 14 16.2	+ 14 49.3	+ 3 43.0	+ 0.6	15 51.3	1.0104236
	14	+ 18 29 5.5	+ 14 30.5	+ 3 43.6	+ 0.0	15 51.1	1.0106379
	15	+ 18 43 36.0	+ 14 11.6	+ 3 43.7	- 0.5	15 50.9	1.0108487
	16	+ 18 57 47.6	+ 13 52.2	+ 3 43.2	- 1.0	15 50.7	1.0110562
	17	+ 19 11 39.8	+ 13 32.7	+ 3 42.1	- 1.6	15 50.5	1.0112606
	18	+ 19 25 12.5	+ 13 12.8	+ 3 40.5	- 2.1	15 50.3	1.0114621
	19	+ 19 38 25.3	+ 12 52.8	+ 3 38.4	- 2.7	15 50.1	1.0116610
	20	+ 19 51 18.0	+ 12 32.4	+ 3 35.7	- 3.2	15 49.9	1.0118574
	21	+ 20 3 50.4	+ 12 11.8	+ 3 32.5	- 3.7	15 49.7	1.0120517
	22	+ 20 16 2.2	+ 11 51.1	+ 3 28.8	- 4.3	15 49.5	1.0122438
	23	+ 20 27 53.3	+ 11 30.0	+ 3 24.6	- 4.8	15 49.4	1.0124339
	24	+ 20 39 23.3	+ 11 8.7	+ 3 19.8	- 5.3	15 49.2	1.0126220
	25	+ 20 50 32.0	+ 10 47.3	+ 3 14.5	- 5.8	15 49.0	1.0128077
	26	+ 21 1 19.3	+ 10 25.5	+ 3 8.6	- 6.3	15 48.8	1.0129911
	27	+ 21 11 44.8	+ 10 3.6	+ 3 2.3	- 6.8	15 48.7	1.0131718
	28	+ 21 21 48.3	+ 9 41.5	+ 2 55.5	- 7.3	15 48.5	1.0133494
	29	+ 21 31 29.8	+ 9 19.2	+ 2 48.2	- 7.8	15 48.4	1.0135234
	30	+ 21 40 49.0	+ 8 56.6	+ 2 40.4	- 8.2	15 48.2	1.0136935
	31	+ 21 49 45.6	+ 8 33.8	+ 2 32.1	- 8.7	15 48.0	1.0138595
JUNE	1	+ 21 58 19.4	+ 8 10.9	+ 2 23.5	- 9.1	15 47.9	1.0140209
	2	+ 22 6 30.3	+ 7 47.8	+ 2 14.3	- 9.5	15 47.7	1.0141774
	3	+ 22 14 18.1	+ 7 24.6	+ 2 4.8	- 9.9	15 47.6	1.0143289
	4	+ 22 21 42.6	+ 7 1.1	+ 1 54.9	- 10.3	15 47.5	1.0144752
	5	+ 22 28 43.7	+ 6 37.6	+ 1 44.6	- 10.6	15 47.3	1.0146160
	6	+ 22 35 21.3	+ 6 13.8	+ 1 34.0	- 10.9	15 47.2	1.0147514
	7	+ 22 41 35.1	+ 5 50.0	+ 1 23.1	- 11.2	15 47.1	1.0148813
	8	+ 22 47 25.1	+ 5 25.9	+ 1 11.9	- 11.5	15 47.0	1.0150057
	9	+ 22 52 51.0	+ 5 1.8	+ 1 0.4	- 11.8	15 46.9	1.0151246
	10	+ 22 57 52.8	+ 4 37.6	+ 0 48.6	- 12.0	15 46.7	1.0152382
	11	+ 23 2 30.4	+ 4 13.2	+ 0 36.7	- 12.2	15 46.6	1.0153466
	12	+ 23 6 43.5	+ 3 48.8	+ 0 24.5	- 12.3	15 46.6	1.0154498
	13	+ 23 10 32.3	+ 3 24.3	+ 0 12.1	- 12.5	15 46.5	1.0155482
	14	+ 23 13 56.6	+ 2 59.7	- 0 0.4	- 12.6	15 46.4	1.0156418
	15	+ 23 16 56.3	+ 2 35.0	- 0 13.0	- 12.7	15 46.3	1.0157308
	16	+ 23 19 31.3	+ 2 10.3	- 0 25.8	- 12.8	15 46.2	1.0158155
	17	+ 23 21 41.6	+ 1 45.6	- 0 38.6	- 12.9	15 46.1	1.0158964
	18	+ 23 23 27.2	+ 1 20.7	- 0 51.5	- 12.9	15 46.1	1.0159736
	19	+ 23 24 47.8	+ 0 56.0	- 1 4.4	- 13.0	15 46.0	1.0160475
	20	+ 23 25 43.8	+ 0 31.2	- 1 17.4	- 13.0	15 45.9	1.0161181
	21	+ 23 26 15.0	+ 0 6.3	- 1 30.4	- 13.0	15 45.9	1.0161856
	22	+ 23 26 21.3	- 0 18.4	- 1 43.3	- 12.9	15 45.8	1.0162502
	23	+ 23 26 2.9	- 0 43.2	- 1 56.2	- 12.9	15 45.7	1.0163115
	24	+ 23 25 19.7	- 1 8.0	- 2 9.1	- 12.8	15 45.7	1.0163697
	25	+ 23 24 11.7	- 1 32.7	- 2 22.0	- 12.7	15 45.6	1.0164242
	26	+ 23 22 38.9	- 1 57.5	- 2 34.7	- 12.6	15 45.6	1.0164748
	27	+ 23 20 41.4	- 2 22.1	- 2 47.3	- 12.5	15 45.6	1.0165212
	28	+ 23 18 19.3	- 2 46.6	- 2 59.8	- 12.3	15 45.5	1.0165631
	29	+ 23 15 32.7	- 3 11.2	- 3 12.1	- 12.2	15 45.5	1.0166001
	30	+ 23 12 21.5	- 3 35.5	- 3 24.3	- 11.9	15 45.5	1.0166318
JULY	1	+ 23 8 46.0	- 3 59.9	- 3 36.2	- 11.7	15 45.4	1.0166581
	2	+ 23 4 46.1	- 4 24.1	- 3 47.9	- 11.5	15 45.4	1.0166789
	3	+ 23 0 21.9	- 4 48.1	- 3 59.4	- 11.2	15 45.4	1.0166938

DATE	DEC	DIFF	EQ OF T	DIFF	SD	DIST
	° ' ''	' ''	M S	S	' ''	AU
JULY 4	+ 22 55 33.8	- 5 12.1	- 4 10.6	- 10.9	15 45.4	1.0167028
5	+ 22 50 21.7	- 5 36.0	- 4 21.5	- 10.6	15 45.4	1.0167059
6	+ 22 44 45.7	- 5 59.6	- 4 32.0	- 10.2	15 45.4	1.0167029
7	+ 22 38 46.1	- 6 23.1	- 4 42.2	- 9.8	15 45.4	1.0166941
8	+ 22 32 23.0	- 6 46.6	- 4 52.1	- 9.4	15 45.4	1.0166792
9	+ 22 25 36.4	- 7 9.7	- 5 1.5	- 9.0	15 45.4	1.0166585
10	+ 22 18 26.6	- 7 32.8	- 5 10.5	- 8.6	15 45.5	1.0166321
11	+ 22 10 53.8	- 7 55.7	- 5 19.1	- 8.1	15 45.5	1.0166001
12	+ 22 2 58.1	- 8 18.4	- 5 27.3	- 7.7	15 45.5	1.0165626
13	+ 21 54 39.7	- 8 40.8	- 5 35.0	- 7.2	15 45.6	1.0165201
14	+ 21 45 58.9	- 9 3.2	- 5 42.2	- 6.7	15 45.6	1.0164726
15	+ 21 36 55.7	- 9 25.3	- 5 48.8	- 6.2	15 45.7	1.0164207
16	+ 21 27 30.4	- 9 47.1	- 5 55.0	- 5.7	15 45.7	1.0163645
17	+ 21 17 43.3	- 10 8.8	- 6 0.7	- 5.1	15 45.8	1.0163044
18	+ 21 7 34.4	- 10 30.3	- 6 5.8	- 4.6	15 45.8	1.0162408
19	+ 20 57 4.1	- 10 51.4	- 6 10.3	- 4.0	15 45.9	1.0161739
20	+ 20 46 12.7	- 11 12.5	- 6 14.4	- 3.5	15 46.0	1.0161039
21	+ 20 35 0.2	- 11 33.2	- 6 17.8	- 2.9	15 46.0	1.0160309
22	+ 20 23 27.0	- 11 53.7	- 6 20.7	- 2.4	15 46.1	1.0159548
23	+ 20 11 33.3	- 12 14.0	- 6 23.1	- 1.8	15 46.2	1.0158757
24	+ 19 59 19.3	- 12 34.2	- 6 24.9	- 1.2	15 46.2	1.0157931
25	+ 19 46 45.1	- 12 53.9	- 6 26.1	- 0.6	15 46.3	1.0157068
26	+ 19 33 51.1	- 13 13.4	- 6 26.8	- 0.1	15 46.4	1.0156167
27	+ 19 20 37.7	- 13 32.7	- 6 26.9	+ 0.5	15 46.5	1.0155224
28	+ 19 7 5.0	- 13 51.8	- 6 26.4	+ 1.1	15 46.6	1.0154236
29	+ 18 53 13.2	- 14 10.3	- 6 25.3	+ 1.7	15 46.7	1.0153200
30	+ 18 39 2.9	- 14 28.9	- 6 23.6	+ 2.3	15 46.8	1.0152115
31	+ 18 24 34.0	- 14 46.9	- 6 21.4	+ 2.8	15 46.9	1.0150979
AUG 1	+ 18 9 47.1	- 15 4.7	- 6 18.5	+ 3.5	15 47.0	1.0149790
2	+ 17 54 42.4	- 15 22.3	- 6 15.1	+ 4.0	15 47.1	1.0148548
3	+ 17 39 20.1	- 15 39.5	- 6 11.0	+ 4.6	15 47.2	1.0147252
4	+ 17 23 40.6	- 15 56.5	- 6 6.4	+ 5.3	15 47.4	1.0145901
5	+ 17 7 44.0	- 16 13.0	- 6 1.1	+ 5.9	15 47.5	1.0144496
6	+ 16 51 31.0	- 16 29.4	- 5,55.2	+ 6.5	15 47.6	1.0143038
7	+ 16 35 1.6	- 16 45.3	- 5 48.8	+ 7.1	15 47.8	1.0141526
8	+ 16 18 16.3	- 17 1.1	- 5 41.7	+ 7.7	15 47.9	1.0139962
9	+ 16 1 15.2	- 17 16.4	- 5 34.0	+ 8.3	15 48.1	1.0138349
10	+ 15 43 58.8	- 17 31.6	- 5 25.8	+ 8.9	15 48.2	1.0136688
11	+ 15 26 27.2	- 17 46.3	- 5 16.9	+ 9.5	15 48.4	1.0134982
12	+ 15 8 40.9	- 18 0.8	- 5 7.5	+ 10.0	15 48.5	1.0133234
13	+ 14 50 40.1	- 18 14.9	- 4 57.4	+ 10.6	15 48.7	1.0131449
14	+ 14 32 25.2	- 18 28.7	- 4 46.8	+ 11.2	15 48.9	1.0129629
15	+ 14 13 56.5	- 18 42.3	- 4 35.6	+ 11.7	15 49.1	1.0127778
16	+ 13 55 14.1	- 18 55.4	- 4 23.9	+ 12.3	15 49.2	1.0125901
17	+ 13 36 18.7	- 19 8.4	- 4 11.7	+ 12.8	15 49.4	1.0124000
18	+ 13 17 10.3	- 19 20.9	- 3 58.9	+ 13.3	15 49.6	1.0122077
19	+ 12 57 49.4	- 19 33.3	- 3 45.6	+ 13.8	15 49.8	1.0120135
20	+ 12 38 16.1	- 19 45.4	- 3 31.8	+ 14.3	15 50.0	1.0118173
21	+ 12 18 30.7	- 19 57.1	- 3 17.5	+ 14.7	15 50.1	1.0116192
22	+ 11 58 33.6	- 20 8.6	- 3 2.8	+ 15.2	15 50.3	1.0114189
23	+ 11 38 25.0	- 20 19.7	- 2 47.6	+ 15.6	15 50.5	1.0112163
24	+ 11 18 5.3	- 20 30.5	- 2 32.0	+ 16.0	15 50.7	1.0110110
25	+ 10 57 34.8	- 20 41.0	- 2 16.0	+ 16.4	15 50.9	1.0108029
26	+ 10 36 53.8	- 20 51.1	- 1 59.6	+ 16.8	15 51.1	1.0105918
27	+ 10 16 2.7	- 21 1.0	- 1 42.8	+ 17.2	15 51.3	1.0103773
28	+ 9 55 1.7	- 21 10.6	- 1 25.6	+ 17.5	15 51.5	1.0101594
29	+ 9 33 51.1	- 21 19.7	- 1 8.1	+ 17.9	15 51.7	1.0099380
30	+ 9 12 31.4	- 21 28.5	- 0 50.2	+ 18.2	15 51.9	1.0097128
31	+ 8 51 2.9	- 21 37.0	- 0 32.0	+ 18.5	15 52.2	1.0094839
SEPT 1	+ 8 29 25.8	- 21 45.3	- 0 13.5	+ 18.8	15 52.4	1.0092511
2	+ 8 7 40.5	- 21 53.0	+ 0 5.3	+ 19.1	15 52.6	1.0090143
3	+ 7 45 47.5	- 22 0.6	+ 0 24.4	+ 19.4	15 52.8	1.0087736

DATE		DEC	DIFF	EQ OF T	DIFF	SD	DIST
		° ' ''	' ''	M S	S	' ''	AU
SEPT	4	+ 7 23 46.9	- 22 7.8	+ 0 43.8	+ 19.6	15 53.1	1.0085291
	5	+ 7 1 39.1	- 22 14.6	+ 1 3.5	+ 19.9	15 53.3	1.0082807
	6	+ 6 39 24.5	- 22 21.1	+ 1 23.3	+ 20.1	15 53.5	1.0080286
	7	+ 6 17 3.4	- 22 27.3	+ 1 43.5	+ 20.3	15 53.8	1.0077732
	8	+ 5 54 36.1	- 22 33.1	+ 2 3.8	+ 20.5	15 54.0	1.0075145
	9	+ 5 32 3.0	- 22 38.6	+ 2 24.3	+ 20.7	15 54.3	1.0072528
	10	+ 5 9 24.4	- 22 43.8	+ 2 45.1	+ 20.9	15 54.5	1.0069887
	11	+ 4 46 40.6	- 22 48.6	+ 3 6.0	+ 21.0	15 54.8	1.0067224
	12	+ 4 23 52.0	- 22 53.1	+ 3 27.0	+ 21.2	15 55.0	1.0064544
	13	+ 4 0 58.9	- 22 57.2	+ 3 48.2	+ 21.3	15 55.3	1.0061851
	14	+ 3 38 1.7	- 23 1.2	+ 4 9.4	+ 21.3	15 55.5	1.0059148
	15	+ 3 15 0.5	- 23 4.6	+ 4 30.8	+ 21.4	15 55.8	1.0056439
	16	+ 2 51 55.9	- 23 7.9	+ 4 52.2	+ 21.4	15 56.0	1.0053727
	17	+ 2 28 48.0	- 23 10.8	+ 5 13.6	+ 21.4	15 56.3	1.0051014
	18	+ 2 5 37.2	- 23 13.5	+ 5 35.1	+ 21.4	15 56.6	1.0048300
	19	+ 1 42 23.7	- 23 15.8	+ 5 56.5	+ 21.4	15 56.8	1.0045585
	20	+ 1 19 7.9	- 23 17.8	+ 6 17.9	+ 21.3	15 57.1	1.0042869
	21	+ 0 55 50.1	- 23 19.5	+ 6 39.2	+ 21.2	15 57.3	1.0040151
	22	+ 0 32 30.6	- 23 20.7	+ 7 0.5	+ 21.1	15 57.6	1.0037428
	23	+ 0 9 9.9	- 23 21.8	+ 7 21.6	+ 21.0	15 57.9	1.0034699
	24	- 0 14 11.9	- 23 22.5	+ 7 42.6	+ 20.9	15 58.1	1.0031961
	25	- 0 37 34.4	- 23 22.7	+ 8 3.5	+ 20.7	15 58.4	1.0029213
	26	- 1 0 57.1	- 23 22.8	+ 8 24.2	+ 20.5	15 58.6	1.0026454
	27	- 1 24 19.9	- 23 22.3	+ 8 44.7	+ 20.3	15 58.9	1.0023681
	28	- 1 47 42.2	- 23 21.5	+ 9 4.9	+ 20.1	15 59.2	1.0020895
	29	- 2 11 3.7	- 23 20.5	+ 9 25.0	+ 19.8	15 59.4	1.0018093
	30	- 2 34 24.2	- 23 19.0	+ 9 44.8	+ 19.5	15 59.7	1.0015277
OCT	1	- 2 57 43.2	- 23 17.1	+ 10 4.4	+ 19.3	15 60.0	1.0012442
	2	- 3 21 0.3	- 23 15.0	+ 10 23.6	+ 19.0	16 0.3	1.0009592
	3	- 3 44 15.3	- 23 12.3	+ 10 42.6	+ 18.7	16 0.5	1.0006723
	4	- 4 7 27.6	- 23 9.5	+ 11 1.3	+ 18.3	16 0.8	1.0003838
	5	- 4 30 37.1	- 23 6.1	+ 11 19.6	+ 18.0	16 1.1	1.0000939
	6	- 4 53 43.2	- 23 2.5	+ 11 37.6	+ 17.6	16 1.4	0.9998026
	7	- 5 16 45.7	- 22 58.3	+ 11 55.2	+ 17.2	16 1.7	0.9995102
	8	- 5 39 44.0	- 22 53.9	+ 12 12.4	+ 16.8	16 1.9	0.9992172
	9	- 6 2 37.9	- 22 49.1	+ 12 29.3	+ 16.4	16 2.2	0.9989239
	10	- 6 25 27.0	- 22 43.9	+ 12 45.7	+ 16.0	16 2.5	0.9986308
	11	- 6 48 10.9	- 22 38.4	+ 13 1.7	+ 15.5	16 2.8	0.9983381
	12	- 7 10 49.3	- 22 32.3	+ 13 17.3	+ 15.1	16 3.1	0.9980463
	13	- 7 33 21.6	- 22 26.1	+ 13 32.3	+ 14.6	16 3.3	0.9977559
	14	- 7 55 47.7	- 22 19.4	+ 13 46.9	+ 14.0	16 3.6	0.9974671
	15	- 8 18 7.1	- 22 12.4	+ 14 0.9	+ 13.5	16 3.9	0.9971804
	16	- 8 40 19.5	- 22 4.9	+ 14 14.4	+ 12.9	16 4.2	0.9968957
	17	- 9 2 24.4	- 21 57.3	+ 14 27.4	+ 12.4	16 4.5	0.9966133
	18	- 9 24 21.7	- 21 49.2	+ 14 39.7	+ 11.7	16 4.7	0.9963332
	19	- 9 46 10.9	- 21 40.7	+ 14 51.5	+ 11.1	16 5.0	0.9960553
	20	- 10 7 51.5	- 21 31.9	+ 15 2.6	+ 10.5	16 5.3	0.9957798
	21	- 10 29 23.4	- 21 22.6	+ 15 13.0	+ 9.8	16 5.5	0.9955063
	22	- 10 50 46.0	- 21 13.1	+ 15 22.8	+ 9.1	16 5.8	0.9952348
	23	- 11 11 59.1	- 21 3.0	+ 15 32.0	+ 8.4	16 6.0	0.9949650
	24	- 11 33 2.1	- 20 52.6	+ 15 40.4	+ 7.7	16 6.3	0.9946968
	25	- 11 53 54.7	- 20 41.8	+ 15 48.1	+ 7.0	16 6.6	0.9944301
	26	- 12 14 36.5	- 20 30.5	+ 15 55.1	+ 6.2	16 6.8	0.9941648
	27	- 12 35 7.0	- 20 18.9	+ 16 1.3	+ 5.5	16 7.1	0.9939007
	28	- 12 55 25.9	- 20 7.0	+ 16 6.8	+ 4.7	16 7.3	0.9936377
	29	- 13 15 32.9	- 19 54.4	+ 16 11.6	+ 4.0	16 7.6	0.9933757
	30	- 13 35 27.3	- 19 41.6	+ 16 15.5	+ 3.2	16 7.8	0.9931144
	31	- 13 55 8.9	- 19 28.4	+ 16 18.7	+ 2.4	16 8.1	0.9928540
NOV	1	- 14 14 37.3	- 19 14.7	+ 16 21.1	+ 1.6	16 8.4	0.9925942
	2	- 14 33 52.0	- 19 0.5	+ 16 22.7	+ 0.8	16 8.6	0.9923350
	3	- 14 52 52.5	- 18 46.1	+ 16 23.5	+ 0.0	16 8.9	0.9920766
	4	- 15 11 38.5	- 18 31.1	+ 16 23.5	- 0.8	16 9.1	0.9918193

DATE		DEC	DIFF	EQ OF T	DIFF	SD	DIST
		° ' ''	' ''	M S	S	' ''	AU
NOV	5	- 15 30 9.6	- 18 15.7	+ 16 22.7	- 1.6	16 9.4	0.9915632
	6	- 15 48 25.3	- 18 0.0	+ 16 21.1	- 2.4	16 9.6	0.9913087
	7	- 16 6 25.3	- 17 43.8	+ 16 18.7	- 3.2	16 9.9	0.9910562
	8	- 16 24 9.1	- 17 27.1	+ 16 15.5	- 4.0	16 10.1	0.9908061
	9	- 16 41 36.2	- 17 10.1	+ 16 11.4	- 4.9	16 10.3	0.9905587
	10	- 16 58 46.3	- 16 52.7	+ 16 6.6	- 5.7	16 10.6	0.9903146
	11	- 17 15 39.0	- 16 34.9	+ 16 0.9	- 6.5	16 10.8	0.9900741
	12	- 17 32 13.9	- 16 16.7	+ 15 54.3	- 7.4	16 11.1	0.9898374
	13	- 17 48 30.6	- 15 58.1	+ 15 46.9	- 8.2	16 11.3	0.9896049
	14	- 18 4 28.6	- 15 39.2	+ 15 38.7	- 9.1	16 11.5	0.9893767
	15	- 18 20 7.8	- 15 19.9	+ 15 29.7	- 9.9	16 11.7	0.9891530
	16	- 18 35 27.7	- 15 0.2	+ 15 19.8	- 10.8	16 11.9	0.9889340
	17	- 18 50 27.9	- 14 40.2	+ 15 9.0	- 11.6	16 12.2	0.9887195
	18	- 19 5 8.1	- 14 19.7	+ 14 57.4	- 12.5	16 12.4	0.9885095
	19	- 19 19 27.8	- 13 58.9	+ 14 45.0	- 13.3	16 12.6	0.9883039
	20	- 19 33 26.7	- 13 37.7	+ 14 31.7	- 14.1	16 12.8	0.9881027
	21	- 19 47 4.4	- 13 16.2	+ 14 17.6	- 14.9	16 13.0	0.9879055
	22	- 20 0 20.6	- 12 54.3	+ 14 2.6	- 15.8	16 13.1	0.9877124
	23	- 20 13 14.8	- 12 32.0	+ 13 46.9	- 16.6	16 13.3	0.9875232
	24	- 20 25 46.8	- 12 9.4	+ 13 30.3	- 17.4	16 13.5	0.9873378
	25	- 20 37 56.2	- 11 46.5	+ 13 12.9	- 18.1	16 13.7	0.9871559
	26	- 20 49 42.7	- 11 23.2	+ 12 54.8	- 18.9	16 13.9	0.9869773
	27	- 21 1 5.9	- 10 59.5	+ 12 35.9	- 19.7	16 14.0	0.9868019
	28	- 21 12 5.4	- 10 35.7	+ 12 16.3	- 20.4	16 14.2	0.9866295
	29	- 21 22 41.1	- 10 11.3	+ 11 55.9	- 21.1	16 14.4	0.9864598
	30	- 21 32 52.3	- 9 46.9	+ 11 34.8	- 21.8	16 14.5	0.9862929
DEC	1	- 21 42 39.2	- 9 21.9	+ 11 13.0	- 22.4	16 14.7	0.9861287
	2	- 21 52 1.1	- 8 56.9	+ 10 50.6	- 23.0	16 14.9	0.9859670
	3	- 22 0 58.0	- 8 31.4	+ 10 27.6	- 23.6	16 15.0	0.9858082
	4	- 22 9 29.4	- 8 5.7	+ 10 3.9	- 24.2	16 15.2	0.9856525
	5	- 22 17 35.1	- 7 39.7	+ 9 39.7	- 24.8	16 15.3	0.9855001
	6	- 22 25 14.8	- 7 13.5	+ 9 14.9	- 25.3	16 15.5	0.9853514
	7	- 22 32 28.2	- 6 47.1	+ 8 49.7	- 25.8	16 15.6	0.9852068
	8	- 22 39 15.3	- 6 20.3	+ 8 23.9	- 26.2	16 15.8	0.9850666
	9	- 22 45 35.6	- 5 53.5	+ 7 57.6	- 26.7	16 15.9	0.9849313
	10	- 22 51 29.1	- 5 26.5	+ 7 31.0	- 27.1	16 16.0	0.9848012
	11	- 22 56 55.6	- 4 59.2	+ 7 3.9	- 27.5	16 16.1	0.9846765
	12	- 23 1 54.8	- 4 31.8	+ 6 36.4	- 27.9	16 16.3	0.9845575
	13	- 23 6 26.5	- 4 4.3	+ 6 8.5	- 28.2	16 16.4	0.9844443
	14	- 23 10 30.8	- 3 36.6	+ 5 40.3	- 28.5	16 16.5	0.9843372
	15	- 23 14 7.4	- 3 8.9	+ 5 11.8	- 28.8	16 16.6	0.9842361
	16	- 23 17 16.3	- 2 40.9	+ 4 43.1	- 29.0	16 16.7	0.9841411
	17	- 23 19 57.2	- 2 13.0	+ 4 14.0	- 29.2	16 16.8	0.9840522
	18	- 23 22 10.2	- 1 44.9	+ 3 44.8	- 29.4	16 16.8	0.9839691
	19	- 23 23 55.1	- 1 16.7	+ 3 15.4	- 29.6	16 16.9	0.9838919
	20	- 23 25 11.7	- 0 48.6	+ 2 45.8	- 29.7	16 17.0	0.9838204
	21	- 23 26 0.3	- 0 20.3	+ 2 16.1	- 29.8	16 17.1	0.9837544
	22	- 23 26 20.6	+ 0 7.9	+ 1 46.3	- 29.9	16 17.1	0.9836938
	23	- 23 26 12.7	+ 0 36.2	+ 1 16.4	- 29.9	16 17.2	0.9836384
	24	- 23 25 36.5	+ 1 4.5	+ 0 46.5	- 29.9	16 17.2	0.9835880
	25	- 23 24 32.0	+ 1 32.7	+ 0 16.6	- 29.8	16 17.3	0.9835422
	26	- 23 22 59.2	+ 2 0.8	- 0 13.2	- 29.8	16 17.3	0.9835009
	27	- 23 20 58.4	+ 2 29.0	- 0 43.0	- 29.7	16 17.3	0.9834638
	28	- 23 18 29.4	+ 2 57.1	- 1 12.7	- 29.5	16 17.4	0.9834305
	29	- 23 15 32.3	+ 3 25.0	- 1 42.2	- 29.3	16 17.4	0.9834010
	30	- 23 12 7.3	+ 3 52.9	- 2 11.5	- 29.1	16 17.4	0.9833750
	31	- 23 8 14.4	+ 4 20.7	- 2 40.6	- 28.8	16 17.5	0.9833526
JAN	1	- 23 3 53.6	+ 4 48.2	- 3 9.4	- 28.5	16 17.5	0.9833336
	2	- 22 59 5.4	+ 5 15.8	- 3 37.9	- 28.2	16 17.5	0.9833186
	3	- 22 53 49.6	+ 5 43.1	- 4 6.1	- 27.8	16 17.5	0.9833075